# AN EVALUATION OF FIVE ICE CREAM DELIVERY SYSTEMS

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## PREFACE

This study is part of a broad research program of the Agricultural Marketing Research Institute, Agricultural Research Service, U.S. Department of Agriculture, on methods and systems of delivering foods to wholesalers and retailers. Its objective is to assess the possibilities for improving these systems. This research was conducted under the former Transportation and Facilities Research Division, ARS.

Acknowledgment is made to the various ice cream manufacturers who made their facilities available and permitted researchers to measure and evaluate various delivery systems, and to the International Association of Ice Cream Manufacturers for their contribution.

This report was prepared under the general supervision of John C. Bouma, chief, Market Operations Research Laboratory, Agricultural Marketing Research Institute, ARS.

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# AN EVALUATION OF FIVE ICE CREAM DELIVERY SYSTEMS

By

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## SUMMARY

A study of five systems for truck delivery of ice cream from the producer to retail and institutional outlets was made.

The primary objectives were: (1) To determine labor productivity when using the different systems, (2) to evaluate different systems by recording fluctuations in ice cream temperatures occurring during transportation from freezer plant to retail stores and institutional outlets, and (3) to determine causes of changes in ice cream temperatures.

Labor costs for assembling and loading the delivery vehicles were less with systems that loaded trucks with orders assembled on carts. The two firms (Systems C and B) that used this method averaged $9.96 and $10.50 respectively, per 500 packages. The three firms (Systems E, D, and A) that stacked orders in delivery trucks by hand averaged $14.82, $15.50, and $21.90 respectively, per 500 packages.

The lowest labor costs (System C), using carts for unloading ice cream at the distribution points, totaled $12.25 per 500 packages. The highest labor costs (System A), using preorder call-in and two-wheel carts for assembly and unloading, totaled $20.44 per 500 packages.

Total labor costs (assembling and loading and unloading) were lowest ($22.21 per 500 packages) in System C, where individual customer orders were assembled on carts and the carts loaded on trucks, unloaded with a hydraulic tail gate, and moved into the retail store.

Ice cream temperatures increased in the five systems when the ice cream was held in the trucks overnight. The system that had the shortest door-opening time per stop experienced a rise of only 6° F from the time of loading to unloading at the last stop (-15° F to -9° F, respectively).

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Door-opening time of delivery trucks with eight doors took 0.15 minute per package, and those with large rear doors took 0.02 minute per package. Door-opening time had an effect on product temperatures during the delivery trip. The two trips with the highest product temperature at the last stop (+8° F and +16° F) were the two trips that had the longest total door-opening times (90 minutes and 73 minutes).

Many variables can affect product temperatures, especially total door-opening time. But other variables, such as inside truck air temperature, outside air temperature, type of refrigeration, and load arrangement, can also affect product temperature.

An ideal ice cream delivery system should be one with ice cream orders preassembled and loaded on carts at the plant freezer by stops. At unloading the individual carts would be removed from the truck and moved directly into the retail store. Door openings would be held to a minimum. The doors would be opened only when the driver entered the truck, left the truck with the cart, and returned the empty cart to the truck.

All delivery operations could be improved by applying principles already known, such as the use of refrigerated instead of nonrefrigerated loading docks, better training of loading crews, better truck interior lighting, and proper maintenance of delivery vehicles.

Better operating procedures at the retail store could help maintain product temperatures, such as putting ice cream away immediately after delivery. Properly maintaining refrigerated storage rooms and display cases would increase salability of the product.

## INTRODUCTION

Five ice cream delivery systems were selected and studied over a 3-month period from July through September 1971. The objectives were to obtain information on the following:

- Labor costs associated with the various systems, including order assembling, loading, and unloading.
- Changes in ice cream temperatures occurring between time of loading the ice cream into the truck and the time of its delivery with different systems.
- Frequency and time intervals of truck door openings.
- Other operational factors that might contribute to the temperature problem, such as inside truck temperature, ambient outside air temperature, and retailers' methods of handling the ice cream immediately after delivery.

The ice cream industry strives to maintain temperature below 0° F in all phases of ice cream distribution, including storage at wholesale warehouses,

transportation to institutional or retail outlets, and holding for use or displaying for sale. From a practical standpoint, however, product temperature may rise above 0° F during delivery; but if it can be brought down below zero by the retailer's freezers, quality will not be impaired.

In delivering ice cream from warehouse to delivery point, one problem in maintaining the below 0° F temperature is the frequency and length of time it takes to open and shut the truck door during each delivery stop. Entry of air into the truck's cargo area affects ice cream temperature, usually causing it to rise, especially during warm weather. Little research literature now exists about the problems associated with actual daily transport and delivery of ice cream and ice cream products between producers and consumers.

The temperatures shown in this report represent only a limited sample from the ice cream systems studied. The temperatures are not representative of the frozen dessert industry. The data are only intended to show variations in product temperature with various handling methods and to provide a guide for minimizing product temperature rise during delivery.

## METHODOLOGY

For each of the five delivery operations, three delivery routes were selected which, in the judgment of the manager, were representative of his operation. The researchers obtained data on one delivery over each of the three routes. Thus, this report is based upon 15 truckloads of ice cream, each hauled in a different vehicle over different routes on different days.

At all five distributors, ice cream orders were assembled and trucks were loaded during the afternoon or evening of the day preceding the delivery. During assembly of the order in the freezer, the researchers selected three half-gallon packages of ice cream to use as test packages. A thermometer inserted into the center of each package remained in the package during the test.

As the truck was loaded, the test packages were placed in the load as follows: One at the front, one near the center, and one at the rear inside the truck body. Just before loading the truck, the researcher hung a thermometer inside the truck to obtain inside air temperature. Another thermometer was carried by the researcher on each delivery to obtain outside air temperature.

Stick-type thermometers, which were checked for accuracy once a week by an ice bath, were used to obtain product and air temperatures.

For each of the 15 truckloads, the researcher observed and recorded the methods used and the time taken to select and assemble the order in the freezer, and to load the truck. Also, during assembling and loading, the number of employees involved and the elapsed time between selecting and assembling the order in the freezer and loading it in the delivery vehicle were recorded. The researcher also accompanied the truck on its delivery.

At the first delivery stop, the researcher read the air temperature inside the truck just after the door was opened, the temperature of the rear test package after it was removed from the truck, and lastly, the outside air temperature. This procedure was repeated with the center test package at the half-way stop (for instance, at the 10th stop on a 20-stop trip). Likewise, the procedure was repeated with the front test package at the last stop. At all the delivery stops, elapsed time for assembling, transporting, and unloading the individual orders was recorded.

## DESCRIPTION OF DELIVERY SYSTEMS

Each of the five delivery operations studied used a different system for moving ice cream from the wholesale warehouse to the delivery points; that is, each system was different from the other systems in one or more of its elements. The four basic elements considered for each system were: Type of refrigerated truck used, method of order assembly, method of loading the truck, and method of unloading the truck.

Following are general descriptions of each system, which are referred to by letter designations: A, B, C, D, and E.

### System A--(Eight-Door Cold Plates, Preorder Call-in Delivery)

The refrigerated truck bodies used in this operation had four access doors on each side (eight doors per truck). The cargo space was divided into eight compartments by means of sheets of expanded metal which allowed exchange of air between compartments. A cold-plate type refrigeration was used. The trucks were precooled before loading.

A preorder, total load method of assembly order was used. The ice cream distributor obtained orders by calling each store the day before delivery. He then made up a loading sheet for each truck, which reflected the total quantity of each item for all orders to be loaded into the vehicle. Thus, the loading crew, when making up the load in the freezer room (fig. 1) did not separate orders by delivery stop. Ice cream was stacked on four-wheel carts (fig. 2) or pallets.

The four-wheel hand carts were moved from the freezer room and positioned next to the truck at street level in a nonrefrigerated area. In loading the truck, one worker handed packages up to another worker who stacked the packages inside the truck. After loading was completed, the electrical power cord of the truck refrigeration system was plugged in for the overnight holding period.

At each delivery stop, the driver, while standing at street level, opened one truck door at a time and reached in to remove ice cream as called for on the order for that stop. He usually opened several doors, and sometimes all eight doors, to fill an order. Since each compartment in the truck usually contained several different ice cream items and since the driver selected items in the sequence shown on the order, it was frequently necessary for him to reopen a door to find a particular item.

Figure 1.--Assembling ice cream orders in the freezer storage area.

As the driver removed ice cream from the truck, he placed the ice cream on a two-wheel or a four-wheel handtruck which then was pushed into the store and positioned next to the ice cream display case. A store employee then verified the count after which the driver usually placed the ice cream in the display case. At a few stops, the store manager did not require the truck driver to place the ice cream in the case, but instead, had one of the store employees perform that task.

System B--(Double Rear Door, Cold Plates, Preorder Call-In Delivery)

Each of the refrigerated truck bodies had a double walk-in door at the rear and one small reach-in door on the right side near the rear of the truck. A cold-plate type of refrigeration was used. The trucks were precooled before loading. A flexible curtain was hung at the rear door to help retain cold air inside the truck when the door was open.

A preorder, total load method of assembly order was used similar to that described for System A. Ice cream was assembled on four-wheel mobile carts (fig. 3) in the freezer and held there until the truck was ready for loading. In the truck-loading operation, four-wheel carts were pushed out of the freezer across a nonrefrigerated loading dock and into the truck. Inside the truck the carts were positioned and clamped against the truck's sides, leaving

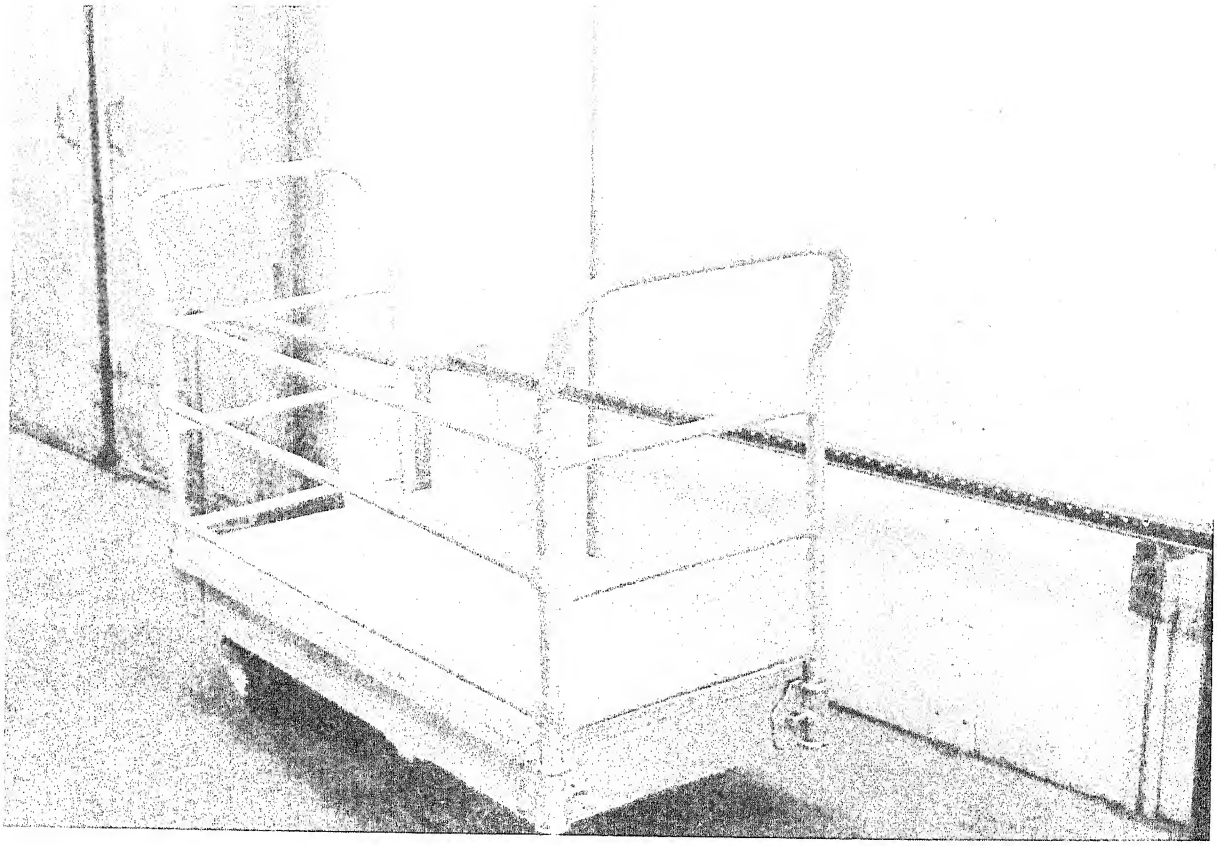

Figure 2.--Loading cart typical of the types used by Systems A and E.

an aisle down the middle. A gap was left between two of the carts on the right side to allow access through the side door. After truck loading was completed, the refrigeration system was activated for the overnight holding period.

At each delivery stop, the driver entered the truck through the rear door, pulled the door shut behind him, and selected the items called for at that stop. He placed the items on the floor near the side door. After leaving the truck through the rear door, he removed the order by reaching through the side door. Ice cream was moved into the retail store and placed in display cabinets in the same manner as for System A.

System C--(Rear Door, Nitrogen, Preorder Call-In On Carts by Stop)

The delivery trucks using this system had one walk-in door at the rear nd were refrigerated by liquid nitrogen. A power-operated lift gate at the ear of the truck was used to move carts up or down between truck bed and :reet level (fig. 4). Trucks were not precooled before loading.

A preorder (call-in) by stop method of assembly order was used wherein :h store phoned in its order which was loaded onto one or more four-wheel :ts in the freezer room.

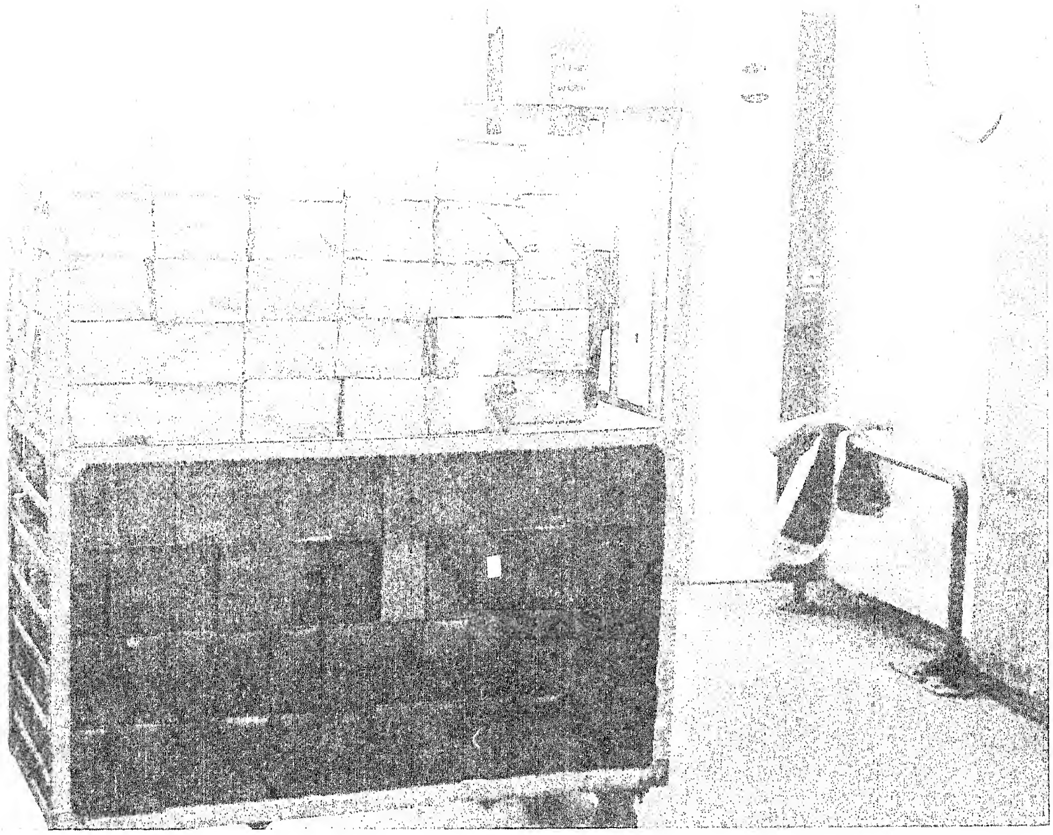

Figure 3.--Mobile cart typical of the types used by Systems B, D, and E.

In the truck-loading operation, trucks were backed up to the door of a refrigerated loading dock which was held at about 40° F. The loaded carts were then pushed out of the freezer across the dock, and into the truck. Carts were secured inside the truck with a brace bar to prevent movement during transit.

At each delivery stop, the driver rolled the carts out the rear door of the truck and onto the lift gate, which was lowered to the ground. Carts were then pushed into the store where the carts were either placed in a walk-in freezer, or the ice cream was transferred from the carts into a display case. Empty carts from previous deliveries were returned on the truck to the ice cream plant.

System D--(Large Rear Door, Cold Plates, Driver-Salesman Delivery)

Trucks in this system had a large rear door for loading and a small door on the right side for unloading. Permanent shelves ran down each side of the truck, except for a gap in the shelves on the right side to allow access through the side door. A cold-plate type of refrigeration was used. Trucks were usually not precooled before loading, since the trucks were loaded

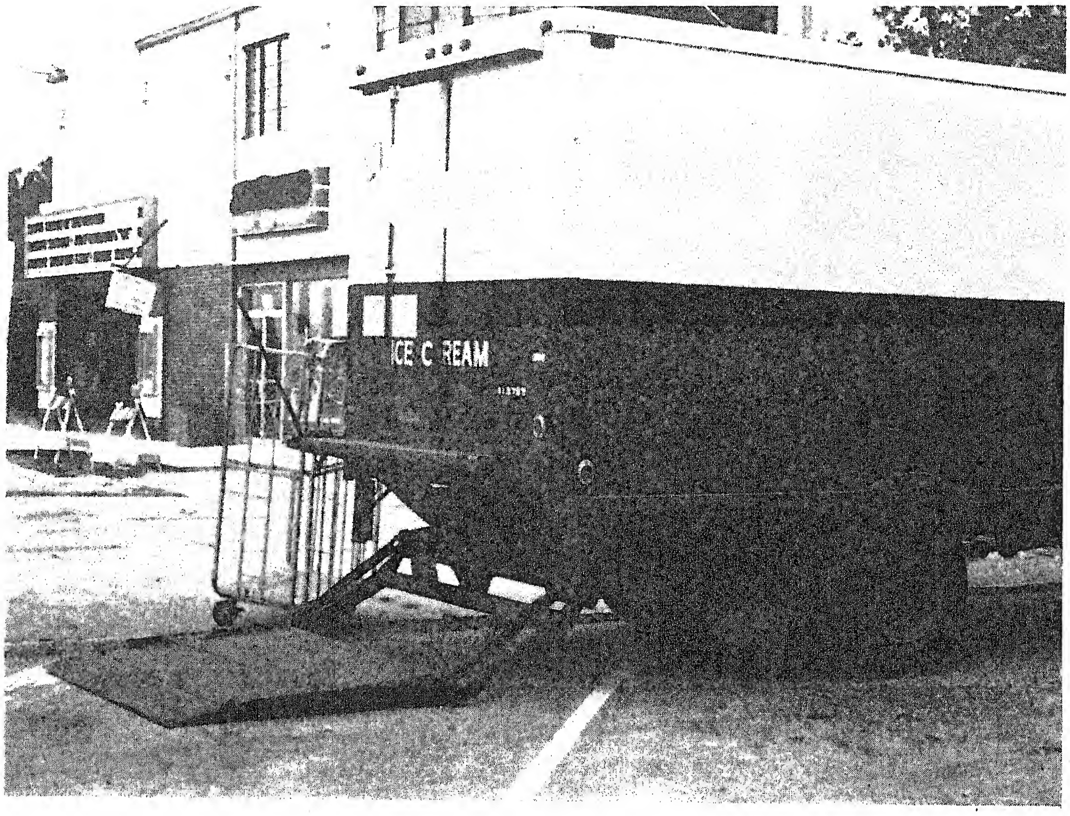


Figure 4.--Delivery truck equipped with a power-operated lift gate.

immediately upon return from the day's delivery and were still cold.

This delivery system was of the type usually referred to as driver-salesman. Before starting on his delivery, the driver gave his order to the loading crew who assembled bulk ice cream items from one freezer and novelty items from another separate freezer. The loading crew placed the bulk items onto four-wheel handtrucks and assembled the novelty items near a gravity roller conveyor which passed through the freezer wall to a loading dock.

When the driver returned from his delivery, carts were rolled out of the bulk freezer room and onto the dock. The loading crew then manually passed packages from the cart to the driver who placed the packages on the shelves in the truck. After the bulk ice cream items were loaded the driver moved the truck to the other freezer where novelty items were placed in the truck by a gravity conveyor. The driver then transferred the novelty items from the conveyor to the truck shelves.

At each delivery stop, the driver proceeded to the ice cream display case in the store where he restacked the disarrayed items already in the case. He then determined what replenishment was needed and wrote up the order. After returning to the truck, he picked the order from the shelves

in the truck and positioned the packages near the side door. From outside the truck, he then removed the packages through the side door and stacked them on a two-wheel handtruck. The handtruck was then wheeled into the store and packages placed in the display case.

System E--(Six-Door, Cold Plates, Driver-Salesman Delivery)

System E was a driver-salesman delivery system with delivery vehicles that had three doors on each side (six doors per truck). The driver transferred packages from the four-wheel carts (fig. 5) into his truck without assistance from the loading crew as in System D. When the loading was completed, the truck's refrigeration system was plugged in for the overnight holding period (fig. 6).

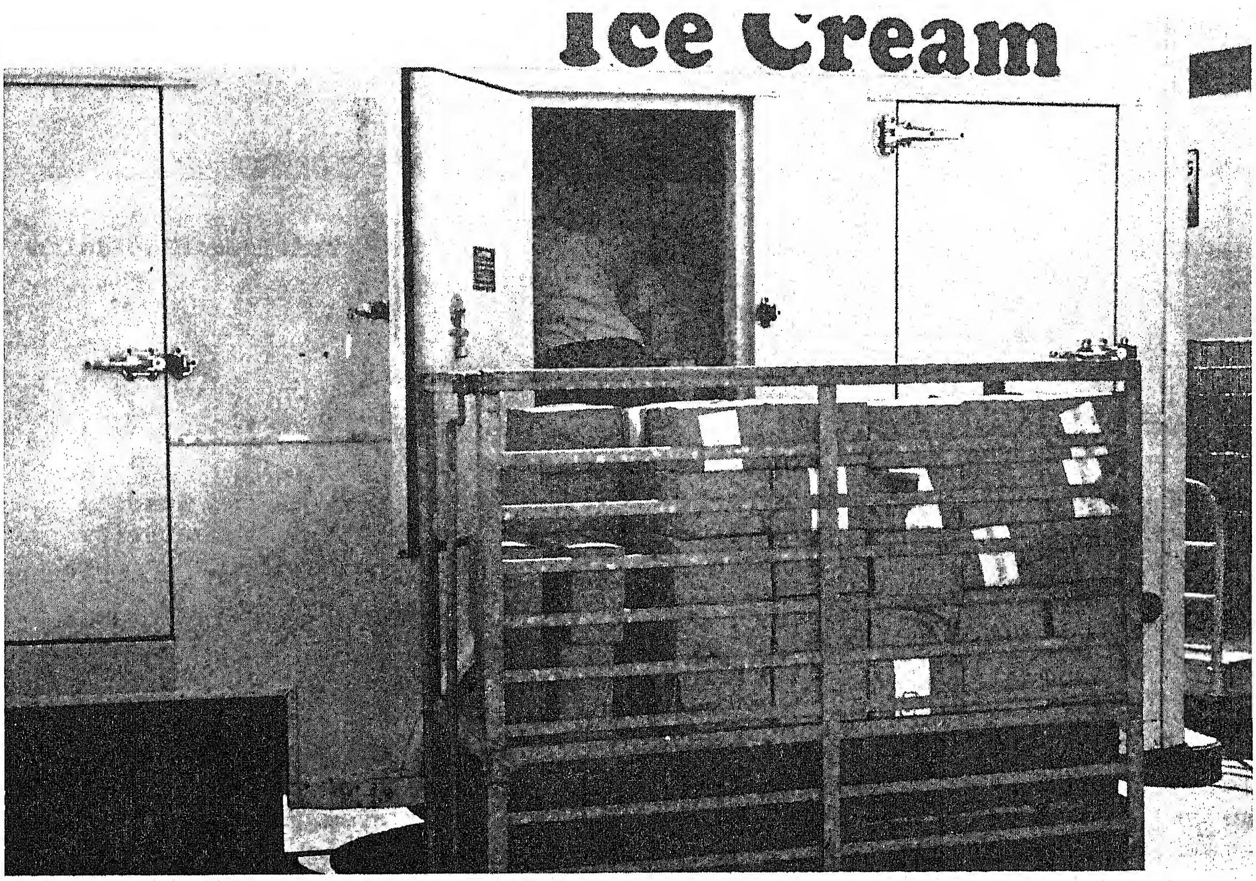


Figure 5.--Loading a multidoor delivery truck.


Figure 6.--Fully loaded multidoor trucks parked with their refrigeration units plugged into electrical outlets.

## EVALUATION OF THE VARIOUS SYSTEMS

### Labor Productivity

Labor productivity was divided into two parts: Assembling and loading the orders at the plant and unloading at distribution points. Productivity among the five systems varied, which resulted in a wide range of labor costs.

#### Assembling and Loading

Labor time for assembling and loading included assembling the orders on selector trucks or carts, loading the delivery vehicle, and number of employees involved. As shown in table 1, System C had the lowest average labor time per package, 0.33 man-minute. System B was next lowest with a labor time per package of 0.35 man-minute. In these two systems, the ice cream was not unloaded from the carts used for assembly as in the truck-loading operation with the other three systems. This reduced labor time during loading in these two systems. In System D, where the driver positioned himself in the truck and stacked the ice cream as it was handed to him by loaders positioned on the dock, labor time per package was 0.50 man-minute. The cooperation between driver and loaders worked very well. In Systems A and E, the labor time per package was 0.73 and 0.47 man-minute, respectively. In System A the loaders moved around the truck loading the appropriate compartment. In System E

TABLE 1.--Productivity in assembly and loading ice cream orders and unloading with 5 systems

| System and Number | Assembly and loading: Number of packages | Labor | Time per package | Packages per man-hour | Labor time for unloading: Per stop | Per package |
|---|---|---|---|---|---|---|
| | | Man-hrs. | Man-min. | No. | Man-min. | Man-min. |
| A (8-door cold plates, preorder call-in): | | | | | | |
| 1 | 584 | 8.7 | 0.89 | 67.1 | 11 | 0.48 |
| 2 | 265 | 2.5 | .57 | 106.0 | 12 | .70 |
| 3 | 427 | 4.3 | .60 | 99.3 | 11 | .58 |
| Average | 425 | 5.2 | .73 | 82.3 | 11 | .58 |
| B (double rear door, cold plates, preorder | | | | | | |
| | 589 | 3.3 | .34 | 178.5 | 22 | .45 |
| | 547 | 2.8 | .31 | 195.4 | 18 | .46 |
| | 432 | 3.0 | .42 | 144.0 | 18 | .54 |
| | 523 | 3.0 | .35 | 172.3 | 19 | .48 |
| r,nitrogen, carts by | | | | | | |
| | 607 | 3.2 | .32 | 189.7 | 24 | .36 |
| | 526 | 2.9 | .33 | 181.4 | 22 | .33 |
| | 533 | 3.1 | .35 | 171.9 | 22 | .37 |
| | 555 | 3.1 | .33 | 181.1 | 23 | .35 |
| ır door, , driver | | | | | | |
| | 380 | 4.0 | .63 | 95.0 | 21 | .45 |
| | 504 | 2.9 | .35 | 173.8 | 27 | .32 |
| | 315 | 3.0 | .57 | 105.0 | 19 | .66 |
| | 400 | 3.3 | .50 | 121.1 | 22 | .42 |

TABLE 1.--Productivity in assembly and loading ice cream orders and unloading with 5 systems, Contd.

| System and Number | Assembly and loading | | | | Labor time for unloading | |
|---|---|---|---|---|---|---|
| | Number of packages | Labor | Time per package | Packages per man-hour | Per stop | per package |
| | | Man-hrs. | Man-min. | No. | Man-min. | Man-min. |
| E (6-door, cold plates, driver salesman): | | | | | | |
| 1 | 177 | 1.3 | .44 | 136.2 | 5 | .42 |
| 2 | 155 | 1.2 | .46 | 129.2 | 6 | .55 |
| 3 | 179 | 1.5 | .50 | 119.3 | 7 | .58 |
| Average | 170 | 1.3 | .47 | 127.8 | 6 | .51 |

the driver performed the entire loading operation. The labor time per package was higher in Systems A, D, and E, because the ice cream was removed from the four-wheel trucks or carts and reloaded in the truck; whereas in Systems B and C, the carts were placed in the truck and secured.

Average package assembling and loading production per man-hour at the plant was highest in System B and C (172.3 and 181.1 packages, respectively). In Systems A, D, and E average man-hour productivity was 82.3, 121.1, and 127.8 respectively.

Package size was generally the same in all five systems. Load size varied from 155 packages in System E to 607 packages in System C.

## Unloading

Labor time for unloading per stop and per package with each of the five systems is also shown in table 1. Labor time included assembling the individual store order in the truck, transporting it into the store; unloading the order in the store for preorder call-in delivery systems; and determining and writing up, assembling, transporting, and unloading the order for the driver-salesman systems. Also included were other functions that were peculiar to a system's delivery operation, such as returning empty delivery carts to the truck, as in System C.

System C had the lowest average labor time per package (0.35 man-minute) at unloading. Store orders were made up before delivery, so at each stop all the driver had to do was to remove the full cart from the truck and return with an empty cart. In Systems A and E (both with multidoor trucks), average time was 0.58 and 0.51 man-minute per package. In Systems A and E, more time was required per package than with the walk-in trucks and preorder call-in deliveries of Systems B and C. System B (preorder call-in) and System D (driver-salesman) trucks and unloading operations were very similar, and the labor time per package was almost the same, 0.48 and 0.42 man-minute. The unloading time was lower in System D than System B because the driver loaded his own truck and knew where everything was located. The lighting was better in the truck also, which made it easier to see when assembling the various items.

Table 2 shows the labor costs for loading and unloading 500 packages of ice cream with each of the five systems. In Systems C and B, where orders were assembled on carts and the carts were loaded on trucks, average assembly and loading labor costs were lowest, $9.96 and $10.50, respectively. This compared with assembly and loading costs of $14.82, $15.50, and $21.90 with Systems E, D, and A, respectively. In Systems D and E the drivers assisted in the loading operations, thus increasing their loading labor cost. In the other three systems (A, B, and C), plant employees performed the entire loading operation.

The lowest labor costs for unloading were achieved with System C ($12.25 per 500 packages). With this system, orders that were assembled on mobile carts at the warehouse were rolled directly into the retail outlet.

TABLE 2.--Labor costs for assembling and loading and unloading 500 packages of ice cream with 5 systems

| System | Assembly and loading | | Truck unloading | | |
|---|---|---|---|---|---|
| | Time required per 500 packages | Cost per 500 packages 1/ | Time required per 500 packages | Cost per 500 packages 2/ | Total cost |
| | Man-hrs. | Dollars | Man-hrs. | Dollars | Dollars |
| A | 6.08 | 21.90 | 4.87 | 20.44 | 42.34 |
| B | 2.92 | 10.50 | 4.03 | 16.94 | 27.44 |
| C | 2.77 | 9.96 | 2.92 | 12.25 | 22.21 |
| D | 4.13 | 15.50 | 3.47 | 14.56 | 30.06 |
| E | 3.92 | 14.82 | 4.30 | 18.06 | 32.88 |

1/ Based on an estimated wage rate of \$3.60 per hour, or \$0.06 per minute for plant employees and \$4.20 per hour, or \$0.07 per minute for the driver.

2/ Based on an estimated wage rate of \$4.20 per hour, or \$0.07 per minute for the driver.

Total labor cost was lowest in System C ($22.21 per 500 packages). System A had the highest total labor cost ($42.34 per 500 packages). Other costs would also be influenced by labor time, such as fixed cost for truck tieup time.

## Door Openings

More door openings were required with System A than any other system because the driver had to open many compartment doors to locate the needed items to assemble the order (table 3).

Average door-opening time per package was shortest in System D, 0.02 minute, compared with 0.15 minute in System A. In Systems B and D, the drivers assembled the order inside the truck with the rear door usually closed. Even though the delivery operations and trucks were very similar between Systems B and D, the average door-opening time per package was higher in System B (0.09 minute) than in System D (0.02 minute), because the lighting was not so good in the trucks used with System B. Also, the drivers occasionally left the rear door open to get better lighting in the truck. In System C, the drivers also left the rear doors open for better lighting, but their orders were already assembled and they did not have to spend as much total time in the truck. A typical multidoor truck at a retailer is shown in figure 7.


Figure 7.--Delivering ice cream to a retailer with a multidoor truck.

TABLE 3.--Number of and length of time for door openings in delivering ice cream with 5 systems

| System and trip number | Number of stops | Average packages per stop | Truck door openings | | | |
|---|---|---|---|---|---|---|
| | | | Total number | Time | Time per package | Time per stop |
| | | | | Min | Min | Min |
| A (8-door, cold plates, preorder call-in delivery): | | | | | | |
| 1 | 25 | 23 | 130 | 90 | 0.16 | 3.60 |
| 2 | 16 | 17 | 60 | 43 | .16 | 2.69 |
| 3 | 22 | 19 | 88 | 56 | .13 | 2.55 |
| Average | 21 | 20 | 93 | 63 | .15 | 3.00 |
| B (double rear door, cold plates, preorder call-in delivery): | | | | | | |
| 1 | 12 | 49 | 70 | 33 | .05 | 2.75 |
| 2 | 14 | 39 | 43 | 73 | .13 | 5.21 |
| 3 | 13 | 33 | 54 | 30 | .07 | 2.31 |
| Average | 13 | 40 | 56 | 45 | .09 | 3.46 |
| C (rear door, nitrogen, preorder call-in on carts by stop): | | | | | | |
| 1 | 9 | 67 | 22 | 38 | .06 | 4.22 |
| 2 | 8 | 66 | 17 | 39 | .07 | 4.87 |
| 3 | 9 | 59 | 18 | 49 | .09 | 5.44 |
| Average | 9 | 64 | 19 | 42 | .07 | 4.67 |
| D (large rear door, cold plates, driver salesman delivery): | | | | | | |
| 1 | 8 | 47 | 27 | 12 | .03 | 1.50 |
| 2 | 6 | 84 | 18 | 7 | .01 | 1.67 |
| 3 | 11 | 29 | 26 | 11 | .03 | 1.00 |
| Average | 8 | 53 | 24 | 10 | .02 | 1.25 |

TABLE 3.--Number of and length of time for door openings in delivering ice cream with 5 system

| System and trip number | Number of stops | Average packages per stop | Truck door openings | | | |
|---|---|---|---|---|---|---|
| | | | Total number | Time | Time per package | Time per stop |
| | | | | Min | Min | Min |
| E (6-door cold plates, driver salesman delivery): | | | | | | |
| 1 | 15 | 12 | 36 | 11 | .06 | .73 |
| 2 | 14 | 11 | 75 | 11 | .07 | .79 |
| 3 | 15 | 12 | 41 | 15 | .08 | 1.00 |
| Average | 15 | 12 | 51 | 12 | .07 | .80 |

## Temperatures

The ice cream temperatures (table 4) increased in all systems while the ice cream was held in the truck overnight (difference between product temperature "at loading" and "first stop"). There were no trips with any system where the ice cream was loaded immediately before delivery.

The smallest rise in ice cream temperature from time of truck loading to last stop was found in System E. With System E, which had the shortest door-opening time per stop, a rise of only 6° F was measured (average of -15° F at loading to -9° F at last stop). The trucks used with System E were in the best condition, freeze plates free of frost buildup, and door gaskets and latches in good condition. Ice cream temperatures at the last stop ranged from an average of -9° F for System E to an average of +5° F for System A.

Comparisons betwen tables 3 and 4 clearly show the effect of door openings on product temperature rise. In trip A1 and B2, total door-opening time was 90 and 73 minutes, respectively. The product temperatures at the last stop were +8° F for trip A1 and +16° F for trip B2. These two trips had the longest total door-opening times and the highest product temperatures at the last stop. The excessive door-opening time for B2 was not typical of System B's other deliveries. The excessive door-opening time occurred when the driver at two stops near the end of the trip left the rear doors open when he backed the truck up to the dock to unload. He could not close the doors without moving the truck.

Systems D and E had the shortest total door-opening times, 10 and 12 minutes, respectively, and had the lowest product temperatures, compared with the other three systems. In their six trips, not once did product temperature rise over -1° F.

## CONCLUSIONS

No company's delivery system was superior in all segments of its operation. Systems B and C had efficient operations at the delivery plant, because the ice cream was handled once--when it was loaded onto carts in the plant freezer. As a result, assembling and loading costs were lower than in the other three systems ($10.50 and $9.96 per 500 packages, respectively). Also, Systems B and C had the highest number of packages assembled and loaded per man-hour (172.3 and 181.1 packages, respectively).

The lowest average door-opening time per package was with System D. Because of good interior lighting, the doors were opened only when the driver entered and left the truck and removed the order. Systems B and C would have had lower average door-opening times per package if they could have avoided occasionally leaving their rear doors open during part of their delivery operation.

System C had the lowest labor cost per 500 packages at unloading ($12.25), because individual store orders had been assembled individually on carts at the plant. At the stop the driver did not have to spend time assembling and loading the order as the other four systems did. System E had the lowest

TABLE 4.--Product temperature, inside truck air and outside air temperatures for 5 delivery systems

| System and trip number 1/ | Temperatures, of | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Product at-- | | | | Air inside truck at-- | | | | Air outside truck at-- | | | |
| | Loading 2/ | First stop 3/ | Mid-stop 4/ | Last stop 5/ | Loading | First stop | Mid-stop | Last stop | Loading | First stop | Mid-stop | Last stop |
| A: | | | | | | | | | | | | |
| 1 | -17 | -2 | 0 | +8 | +15 | + 4 | + 6 | +30 | 81 | 76 | 87 | 83 |
| 2 | -11 | +5 | +3 | +4 | +36 | +16 | +22 | +27 | 78 | 74 | 78 | 82 |
| 3 | -15 | +3 | -4 | +2 | +25 | + 3 | + 8 | +16 | 78 | 75 | 86 | 88 |
| Average | -14 | +2 | 0 | +5 | +25 | + 8 | +12 | +24 | 79 | 75 | 84 | 84 |
| B: | | | | | | | | | | | | |
| 1 | -16 | -14 | -12 | -7 | +50 | -14 | - 6 | + 4 | 74 | 58 | 68 | 72 |
| 2 | -19 | -12 | - 3 | +16 | +50 | - 8 | + 9 | +23 | 72 | 67 | 76 | 83 |
| 3 | -23 | -12 | - 7 | -16 | +52 | - 2 | 0 | +10 | 70 | 68 | 73 | 85 |
| Average | -19 | -13 | - 7 | -2 | +51 | - 8 | + 1 | +12 | 72 | 64 | 72 | 80 |
| C: | | | | | | | | | | | | |
| 1 | -14 | -4 | - 6 | 0 | +35 | 0 | +10 | - 8 | 82 | 75 | 80 | 83 |
| 2 | -19 | -1 | + 5 | +6 | +53 | + 3 | +20 | + 4 | 67 | 67 | 78 | 85 |
| 3 | -20 | -3 | + 4 | +6 | +55 | + 6 | +35 | + 6 | 68 | 67 | 74 | 76 |
| Average | -18 | -3 | + 1 | +4 | +48 | + 3 | +22 | + 1 | 72 | 70 | 77 | 81 |
| D: | | | | | | | | | | | | |
| 1 | -22 | -8 | - 4 | -3 | +48 | 0 | 0 | + 4 | 77 | 56 | 61 | 68 |
| 2 | -24 | -8 | - 6 | -3 | +42 | + 3 | + 3 | + 3 | 68 | 64 | 69 | 73 |
| 3 | -20 | -9 | - 3 | -1 | +40 | -12 | - 3 | 0 | 69 | 58 | 63 | 70 |
| Average | -22 | -8 | - 4 | -2 | +43 | - 3 | 0 | + 2 | 71 | 59 | 64 | 70 |
| E: | | | | | | | | | | | | |
| 1 | -15 | -11 | -12 | -15 | + 5 | -20 | -15 | -10 | 72 | 63 | 67 | 76 |
| 2 | -16 | -16 | -15 | - 9 | - 5 | -25 | -15 | - 5 | 76 | 67 | 68 | 72 |
| 3 | -15 | - 4 | - 4 | - 4 | - 4 | -10 | - 8 | + 6 | 77 | 66 | 71 | 71 |
| Average | -15 | -10 | - 9 | - 9 | - 1 | -18 | -13 | - 3 | 75 | 65 | 69 | 73 |

TABLE 4.--Product temperature, inside truck air and outside air temperatures for 5 delivery systems

1/ "Average" denotes average values for the 3 delivery trips.
2/ Average of 3 test packages.
3/ Test package No. 1.
4/ Test package No. 2.
5/ Test package No. 3.

average product temperatures (-9° F) at destination.

Even though products sometimes arrived at the retailers relatively soft, there were no instances when the retailer refused delivery. The ice cream companies did a good job, sometimes under difficult conditions, of delivering their product in good condition and on time. The ice cream industry also strives to maintain a product of highest quality and to deliver that product in the best condition possible. As a whole, the ice cream industry has been successful in this endeavor.

Based on this study, an ideal ice cream delivery system should comprise the most efficient aspects of the five systems studied. Orders should be called in by the retail stores and be preassembled and loaded on carts by stop at the warehouse freezer at loading time. It is no greater effort for the warehousemen to assemble and load a cart by stop than by product type. But, if the preorder on carts system is used, retail outlets will have to determine their own needs and not rely on driver-salesmen. In general, retail clerks have a lower pay scale than delivery truck drivers and the high fixed cost of delivery vehicles is not incurred when store orders are made up by store employees. At unloading, drivers will not spend time assembling store orders in the trucks. Trucks should be well lighted to avoid the need for drivers to keep the doors open while they work in the truck. In all systems product temperatures rose when the ice cream was held in the trucks overnight. Therefore, an ideal delivery system would provide for loading the vehicle the morning of delivery by using a rapid loading method, such as preassembled orders on mobile carts.

## PROCEDURES CONTRIBUTING TO INEFFICIENCIES IN EXISTING SYSTEMS

The researchers noted the following practices in one or more of the systems which tend to cause inefficiencies in ice cream deliveries:

At the ice cream plant

- Short order--the loading crew at the freezer plant sometimes miscounted and put a smaller quantity of an item on the truck than called for on the load sheet. Consequently, at one of the delivery stops, the driver spent considerable time looking for an item that actually was not in the truck.

- Misplaced items--sometimes the loaders would not put all of a particular item at one location in the truck. For instance, the load sheet might call for 20 half-gallons of chocolate, and the loader would put 16 packages in one compartment and 4 in another. Subsequently, the driver would spend much time trying to locate the 4 packages that were separated from the main group of 16. In this connection, the "driver-salesman" (Systems D and E) had no trouble locating items. Evidently, this was because he loaded his own truck and knew the location of all items. The drivers in Systems A and B did not load their own trucks. Consequently they spent more time in hunting for items.

- Uneven loading of compartmentized vehicles--the loaders sometimes loaded one compartment to the ceiling, while leaving other compartments empty. As a result, the relatively high-stacked load of ice cream toppled during transit. Also, removal of the packages from the middle of the high-stacked load was difficult for the driver.

- Package labeling not visible--in loading the truck, the loaders positioned packages with the product labels facing away from the driver, thus making it difficult for the driver to identify items.

- Ice cream on nonrefrigerated dock--sometimes, a pallet load of ice cream would be brought out on the dock, and half of the pallet load would be put into a truck. Instead of returning the rest of the pallet load of ice cream to the freezer until the next truck was available for loading, the pallet was allowed to remain on the nonrefrigerated dock. Thus the remaining ice cream might be exposed to warm air for some time before it was loaded into a truck.

At the truck

- Loose-fitting doors and gaskets, which allowed cold air to escape and warm air to enter, were observed on a few trucks.

- Poor interior lighting, which caused drivers to leave their doors open occasionally while assembling orders, was observed at some delivery stops.

- Heavy frost allowed to buildup on cold plates over a period of days decreased refrigeration efficiency.

- Truck floors covered with ice, causing packages to slide and load to shift, resulted in damaged and broken packages. Also, ice was a safety hazard to the driver as he moved inside the truck.

At the retail store

- Store personnel allowed ice cream to sit on the floor for some time before checking the count and putting the product in the refrigerated display case.

- Over ordering--display case was not large enough to hold the order, so some of the ice cream had to be returned, moved to a holding freezer, or transferred to another store.

- Delivery restrictions--some stores allowed delivery only at certain hours. This practice made it necessary for the driver to go out of his way to be at a particular store at a stated time.

- <u>Improper maintenance</u>--retailers maintaining refrigerated storage rooms and display cases improperly could decrease the salability and shelf life of the product.



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